

## VECTORS vs SCALAR

A *scalar* quantity is one that can be described by a single number:  
temperature, speed, mass

A *vector* quantity deals inherently with both magnitude and direction:  
velocity, force, displacement

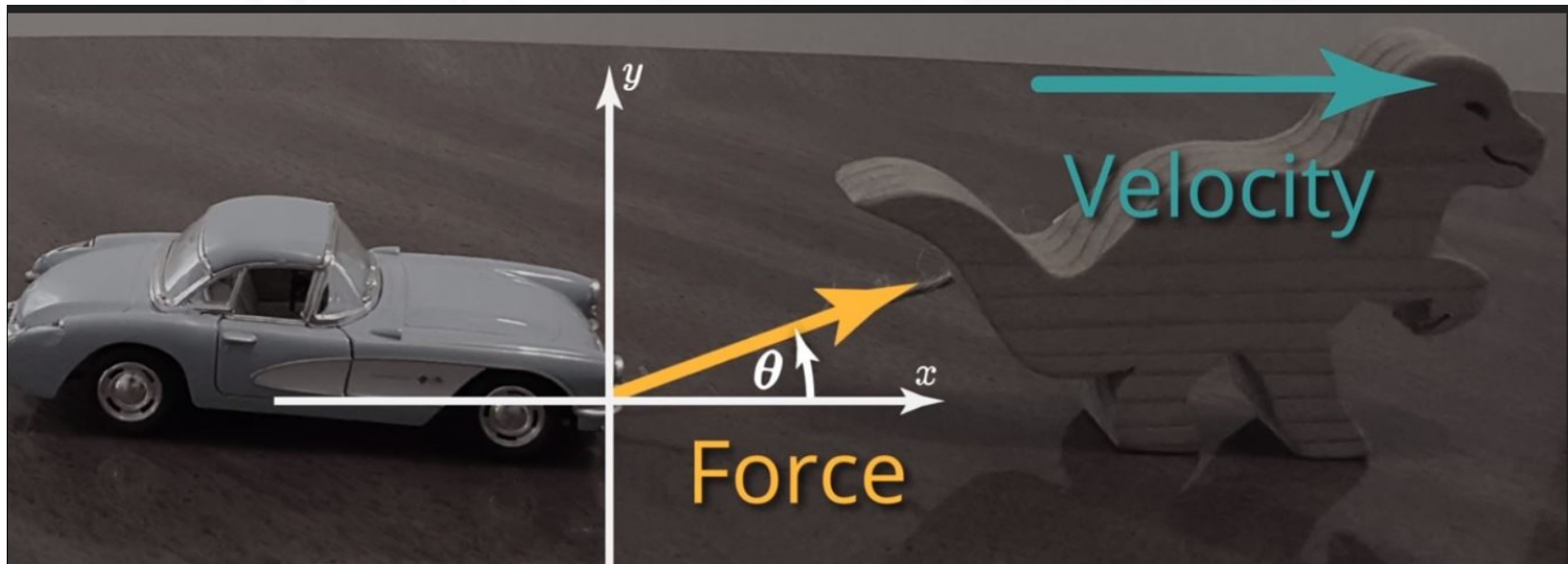
HOW MUCH ? OF WHAT ? WHICH WAY ?

WHICH quantity is not a vector

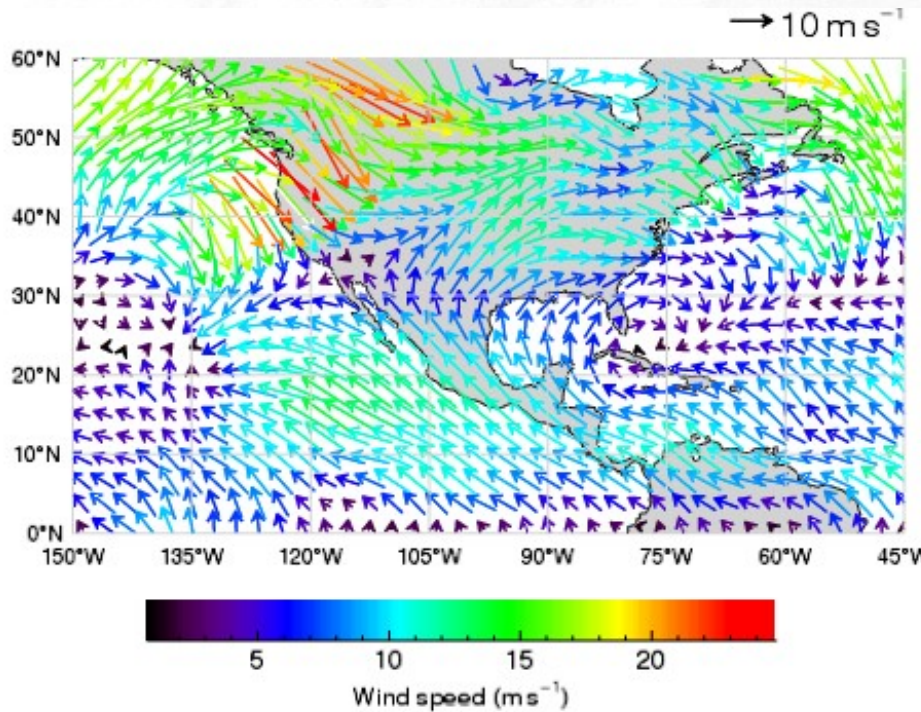
1. force
2. speed
3. acceleration
4. displacement

WHICH quantity is a scalar

1. distance
2. velocity
3. acceleration
4. displacement



## VECTOR FIELD



This map shows the velocities of the Wind. The velocities have a magnitude, units and direction

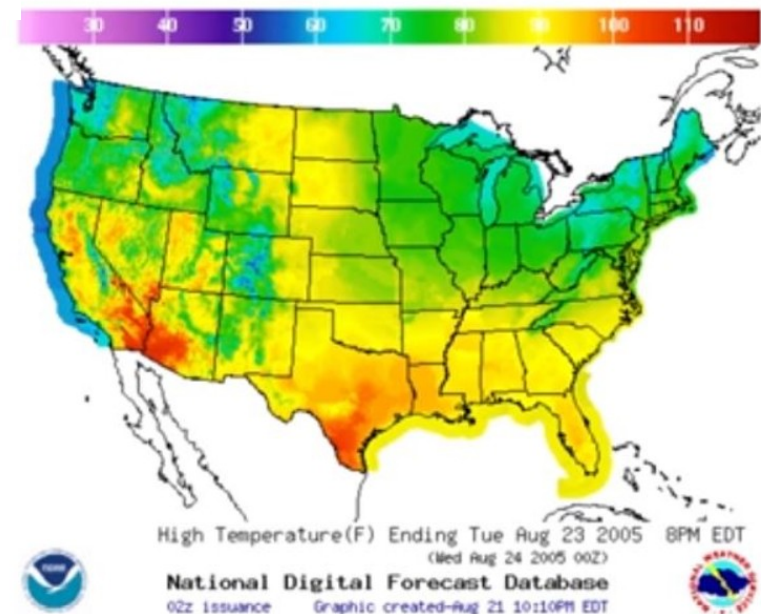
The velocities have a magnitude (speed of wind from 0 to 25)

The length of the arrows are proportional to the magnitude.

Colors are also used to show the magnitude.

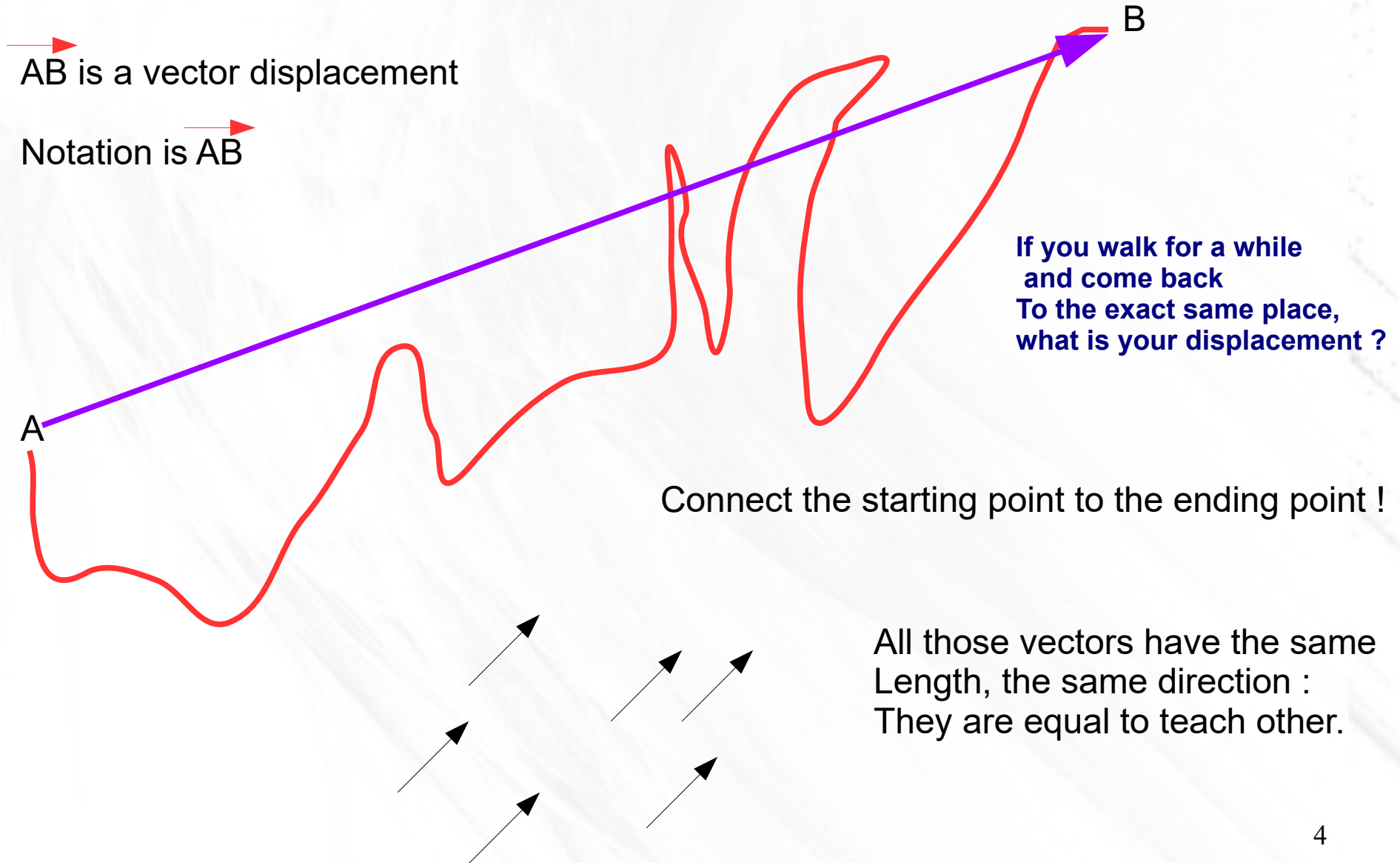
<https://www.harrisgeospatial.com/docs/vectors.html>

## SCALAR FIELD

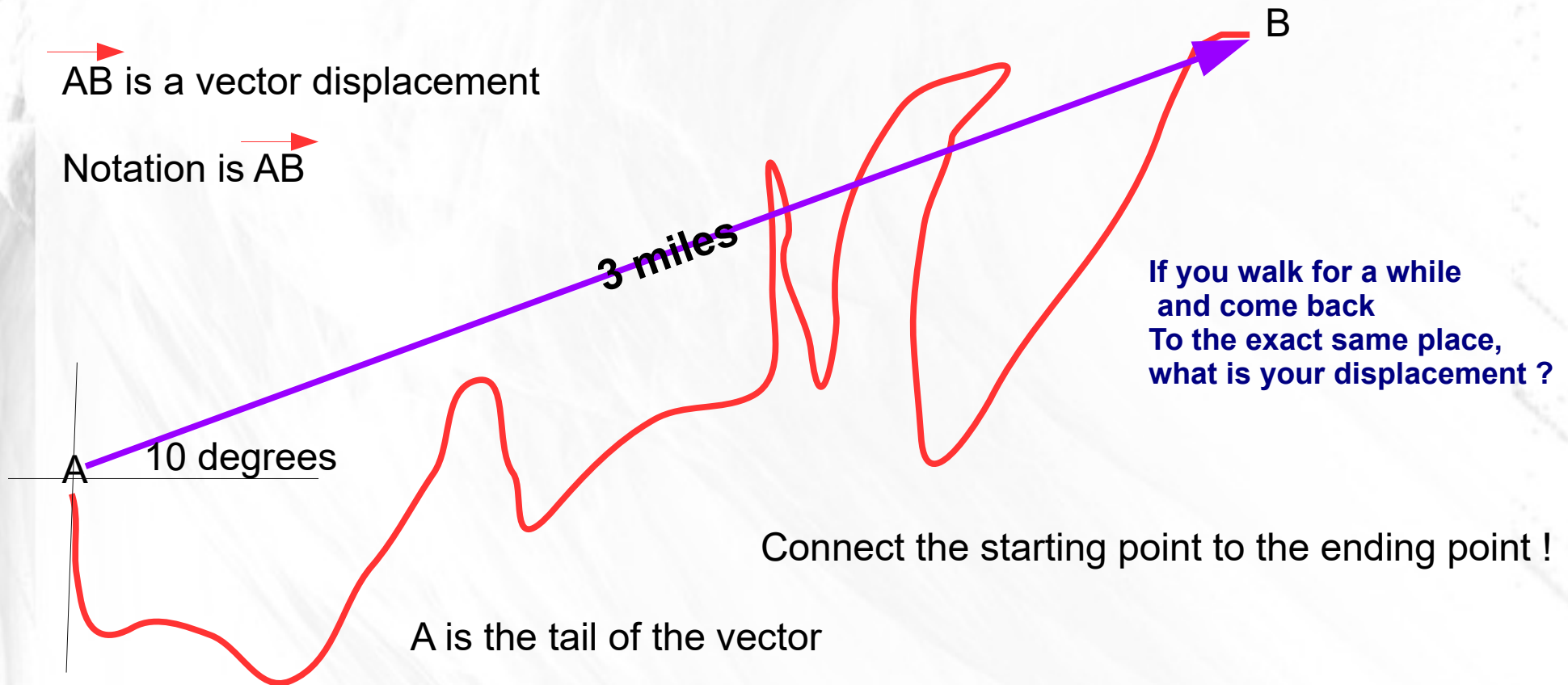




**Trace the vector displacement : connect the starting point A to the end point B. A is the tail of the vector and B the head.**



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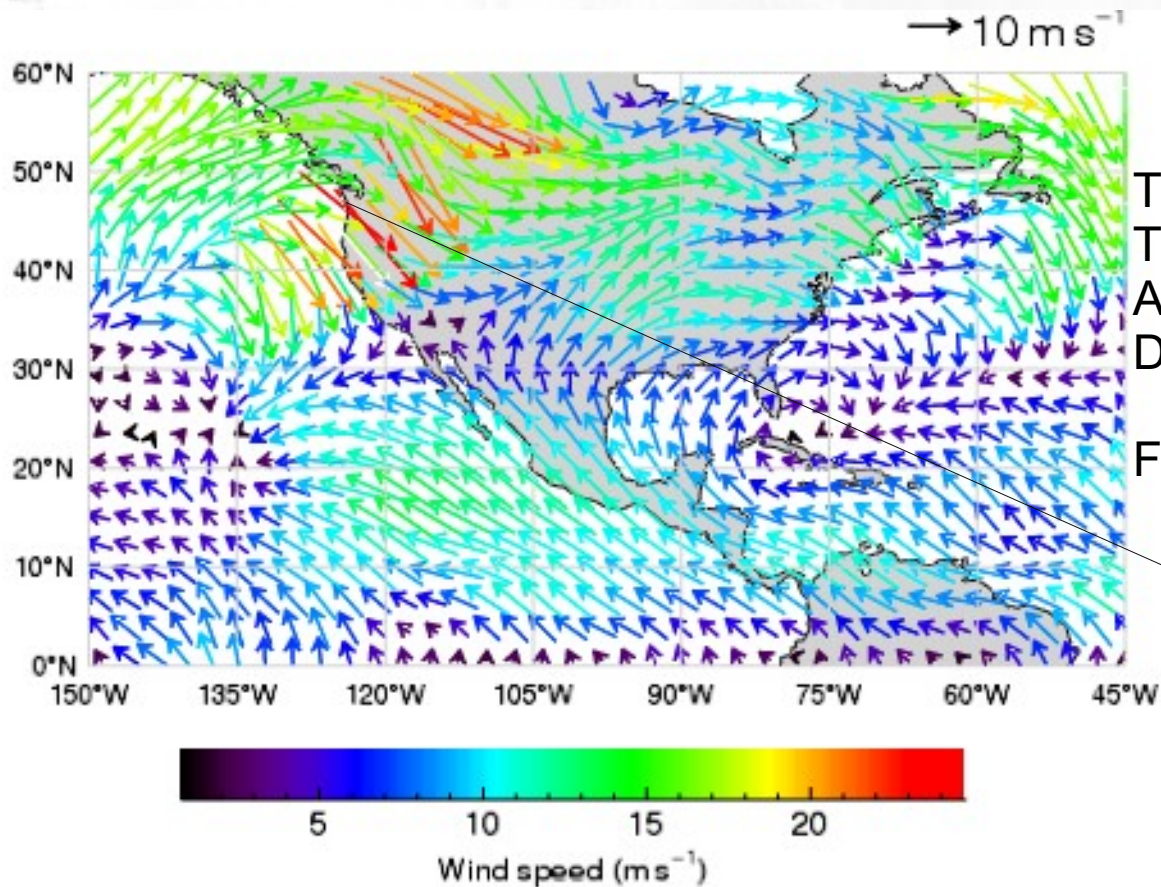
A is the tail of the vector

B is the head of the vector

The length of the segment AB (3 miles here) is the magnitude

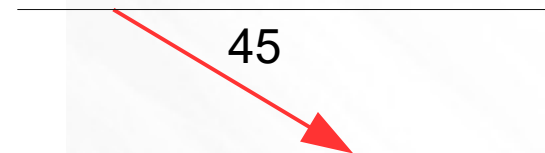
The direction is 10 degrees North of East

AB=3miles @ 10 degrees N of E (or just 10)



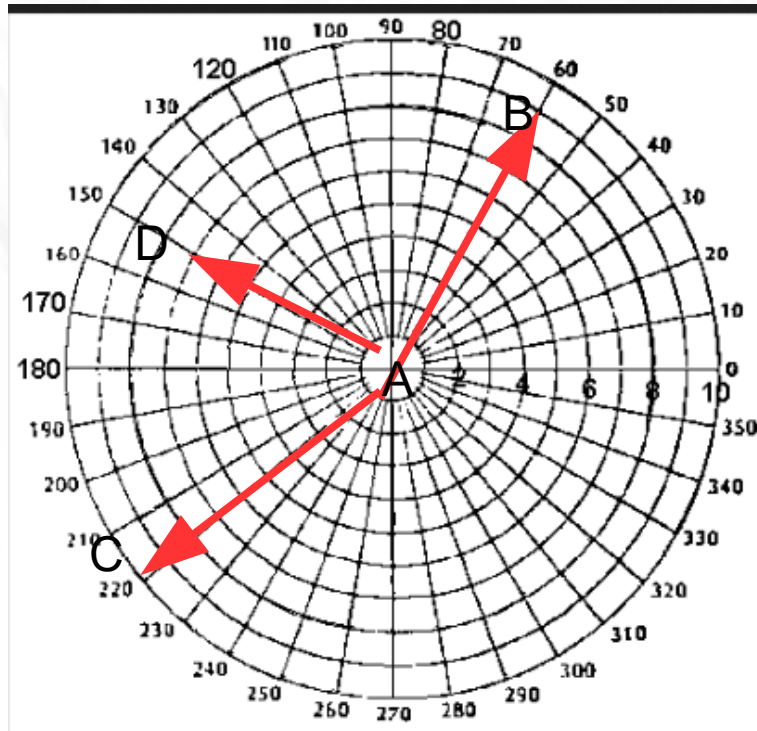
These are velocity vectors.  
The magnitudes are given by the colors  
And by the scale at the top right of figure.  
Direction can be approximated.

For example:



30m/s @ 45 degrees south of east

# Polar coordinates of vectors or standard notation



In polar coordinates, the angle increase  
From the positive x-axis counterclockwise  
From 0 to 360

For example vector AB = 9 units @ 60

AC = 10 units @ 220

This is called the standard notation for  
Vectors.

AD =



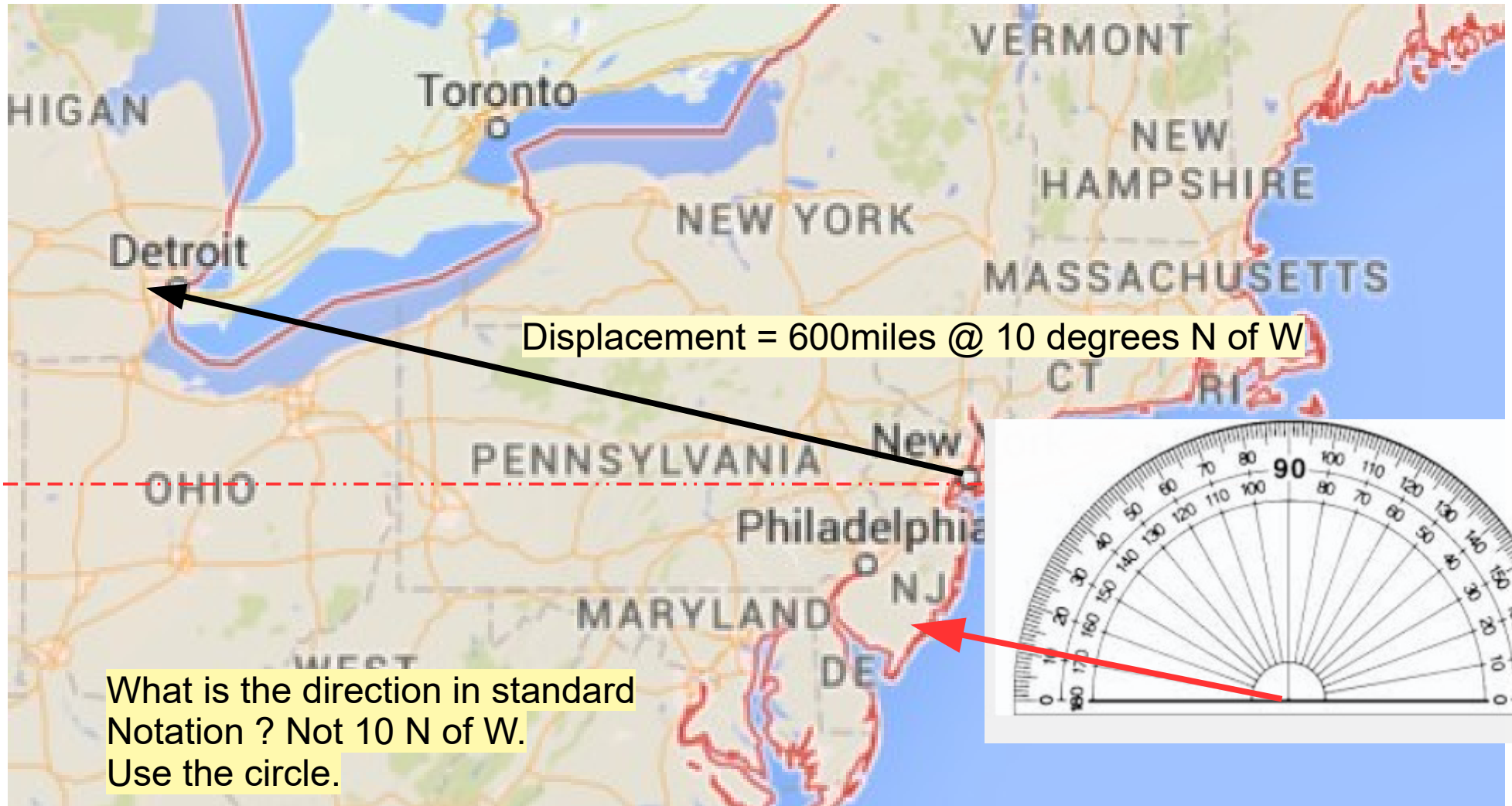


The vector represents the displacement  
NYC – Detroit.

It has magnitude, a unit, a direction

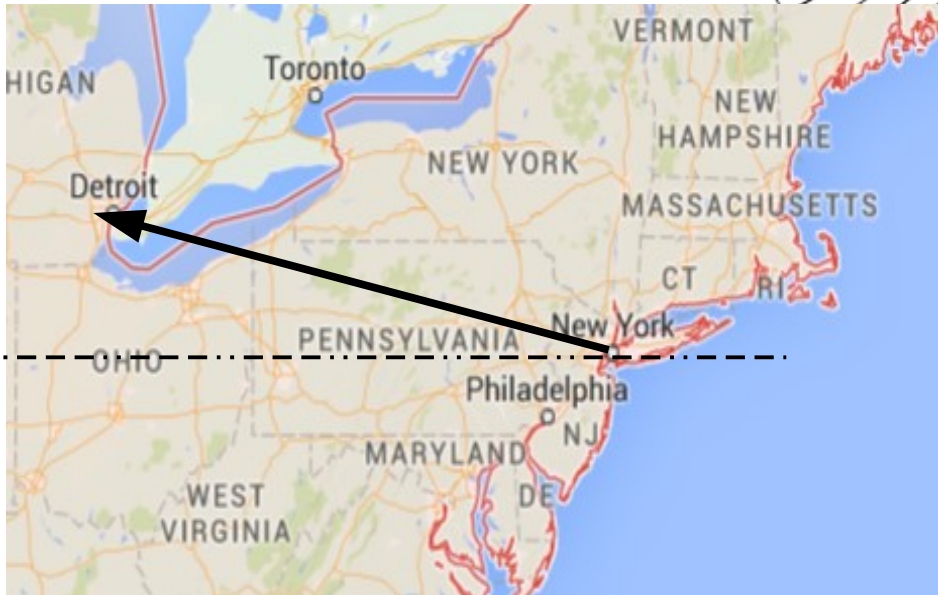
Displacement = \_\_\_\_\_ @ \_\_\_\_\_

The distance in blue is a scalar.





It is the polar notation  
Or standard notation  
See doc polar coordinate.



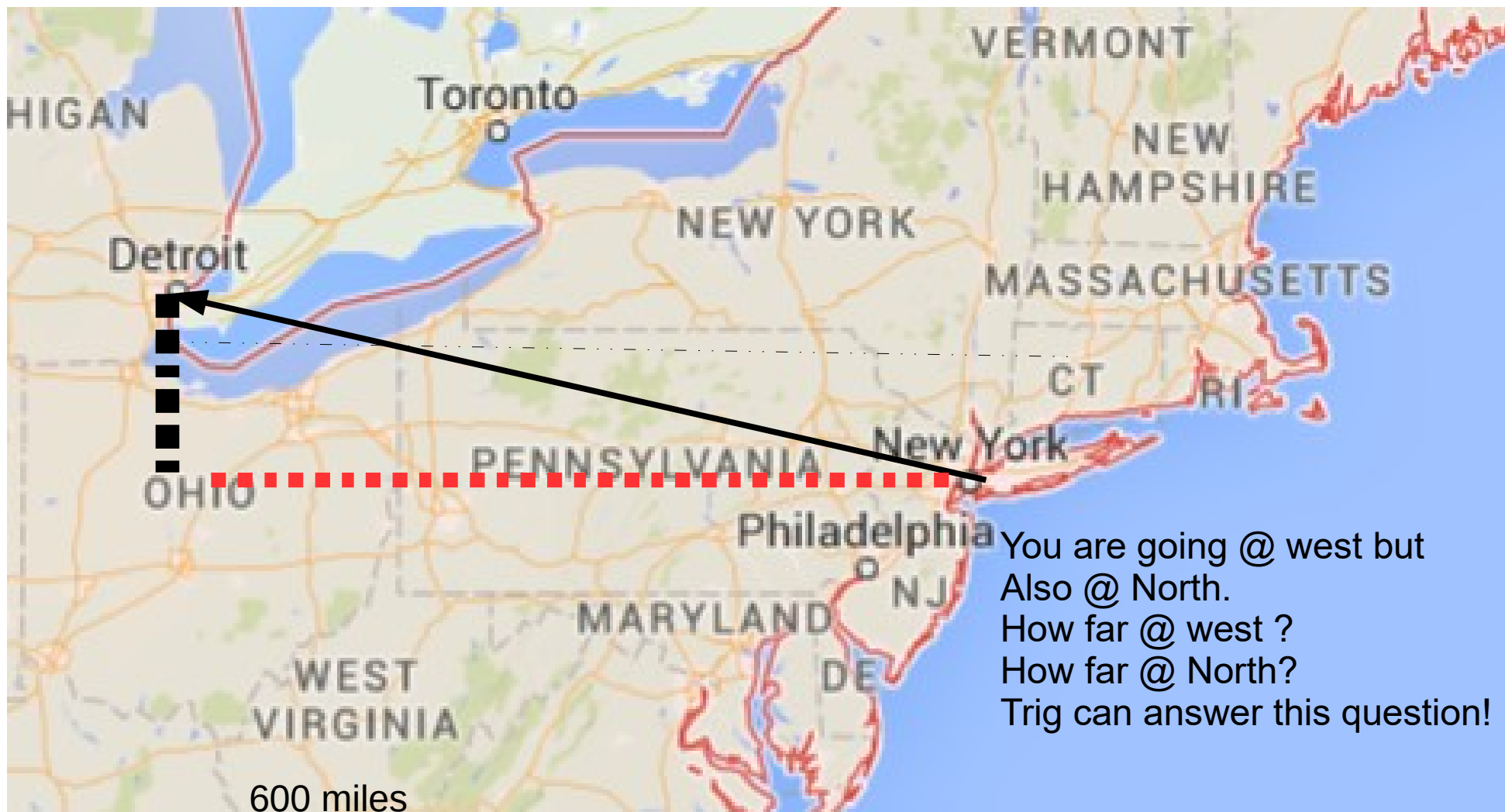
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## VECTORS in PARTS: components of vectors

**Vectors come in parts. A vector has 2 components in 2D.**

**A horizontal component along the x-axis or W-E direction  
and a vertical component along the y-axis or the S-N direction**

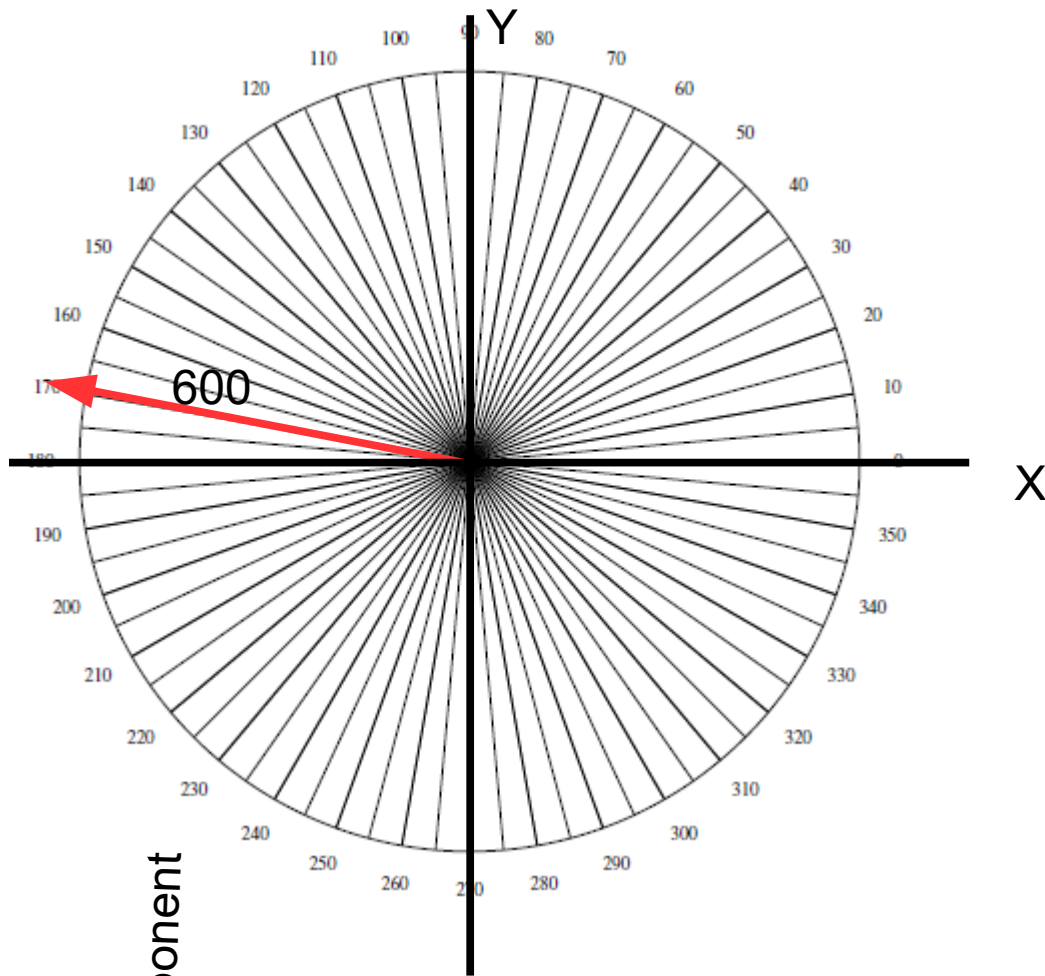
**Here you can find how far in the West direction and how far in the North direction**



Find the components of the vector displacement.

The magnitude is 600 miles and the angle is 170 degree. Use trig.

From tail run then rise/fall to find the head.



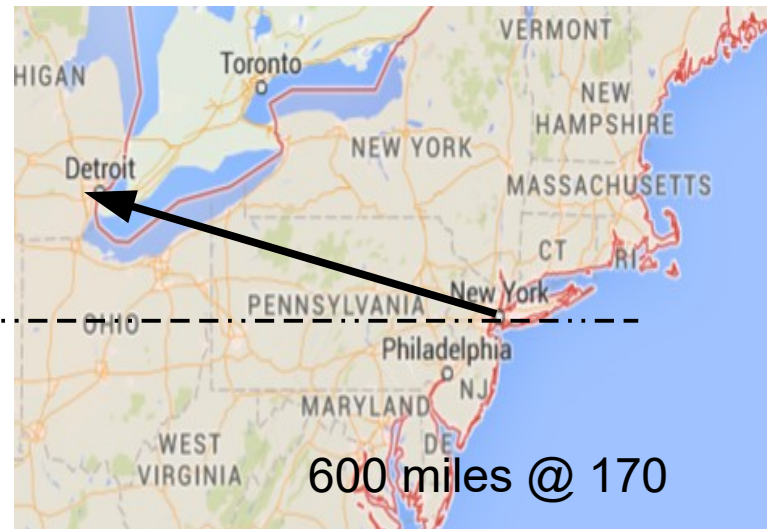
rise=y-component  
run=x-component

How far west ?  $\rightarrow$  x-component  
(run)

$$600 \cos(170) =$$

How far North ?  $\rightarrow$  y-component  
(rise/fall)

$$600 \sin(170) =$$



600 miles @ 170

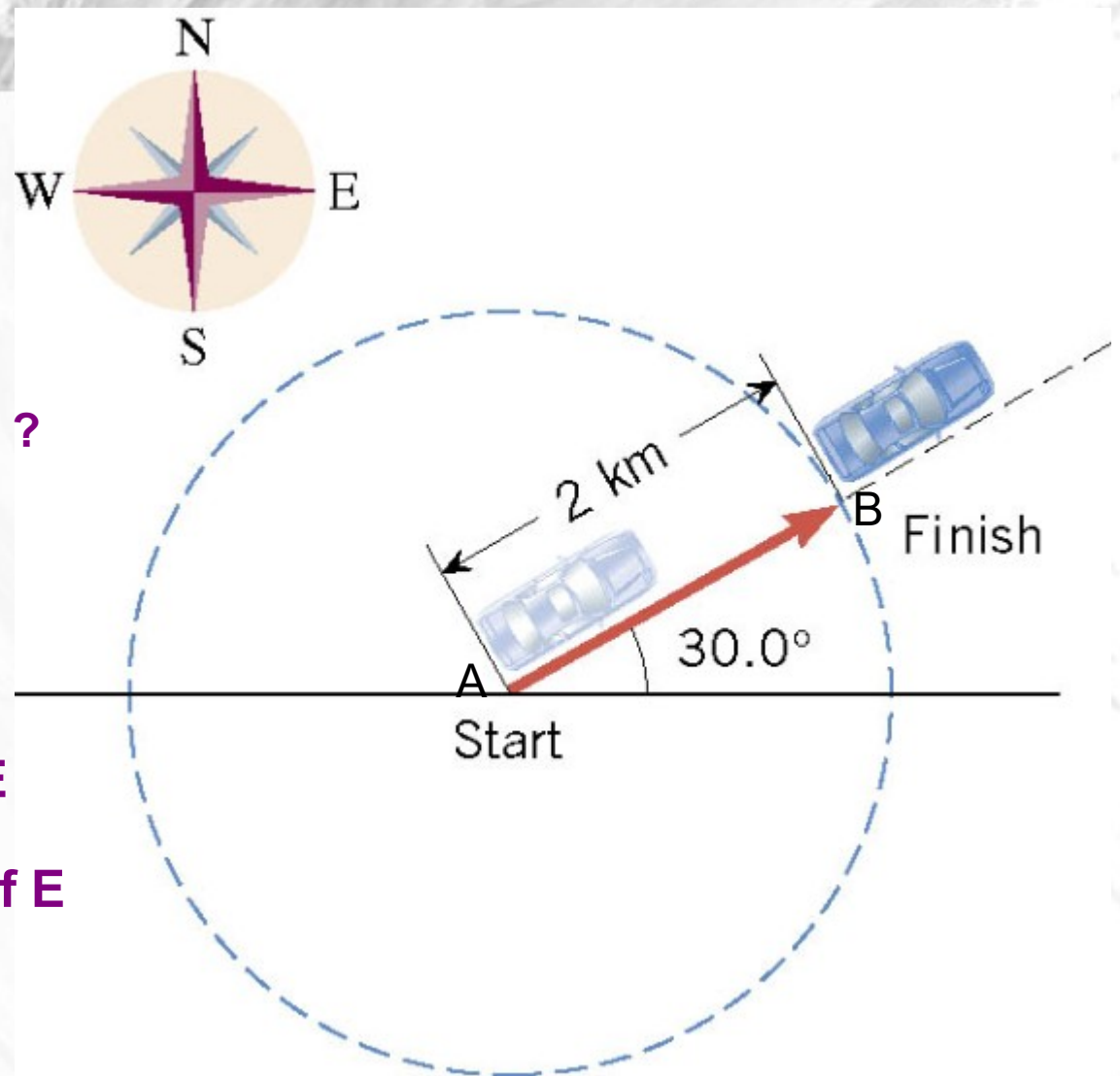


# finding components of vectors

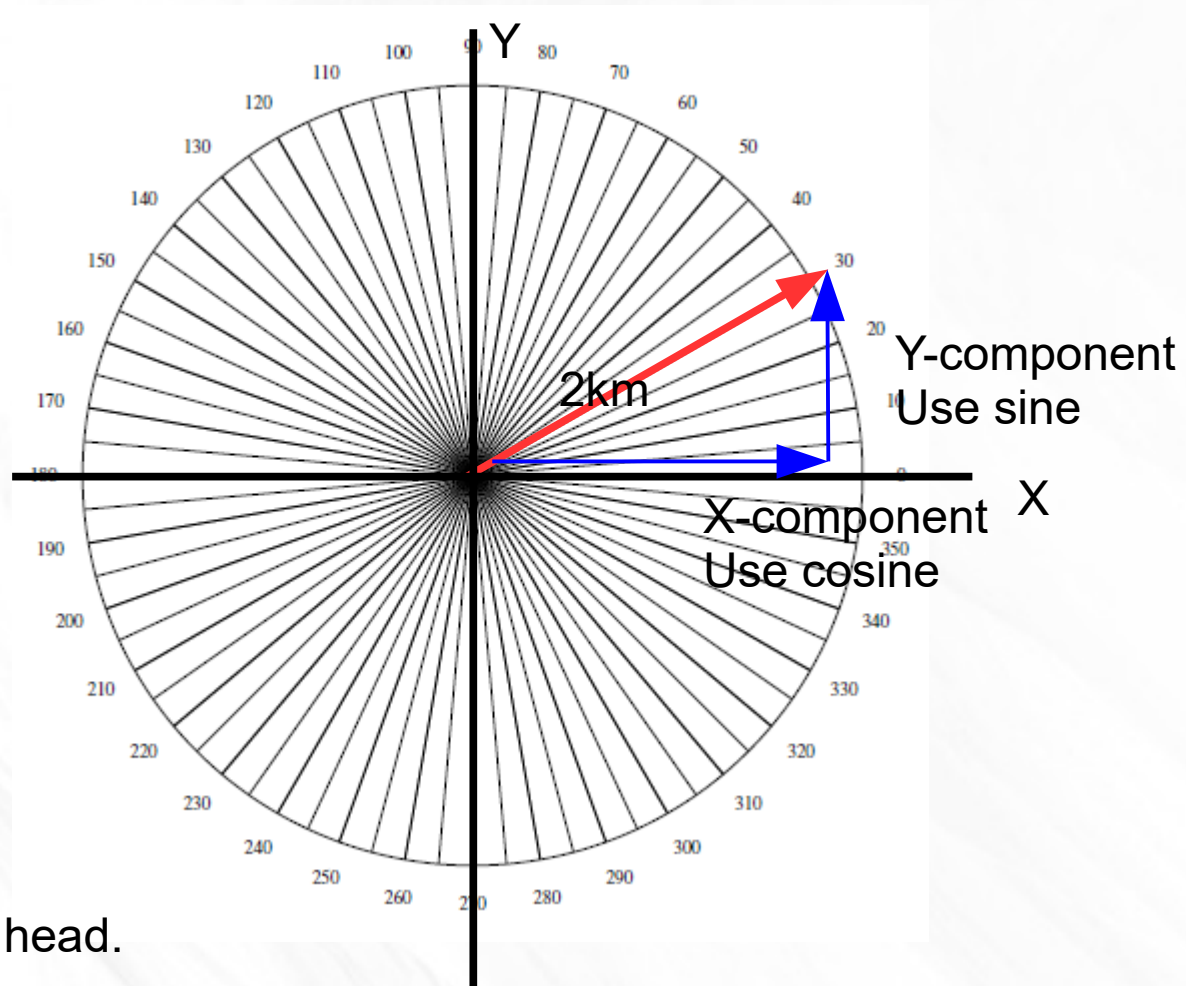
- Vector has a magnitude + direction
- Attach the tail of the vector at the origin of a x-y coordinate system. Keep the direction the same.
- Using a polar graph find the angle in the circle. (go counterclockwise)
- X-component is magnitude  $\times$  cosine(angle)
- Y-component is magnitude  $\times$  sine(angle)

**What is the displacement of the car ?**  
(2 answers are correct)

- 1. **AB = 2km @ 30 degrees**
- 2. **AB = 2 @ 30 degrees N of E**
- 3. **AB = 2km @ 30 degrees N of E**
- 4. **AB = 2 km @ 170 degrees N of E**



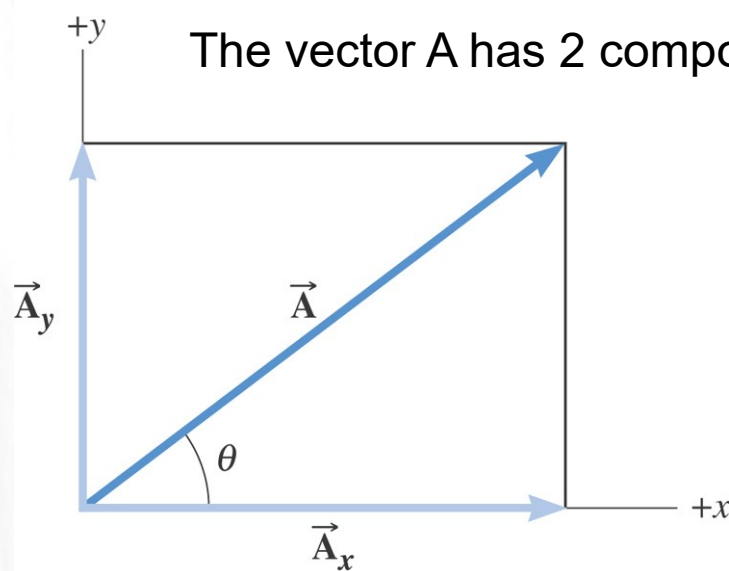
**Compute the components of the vector displacement  
(x-component and y. component) See next slide.**



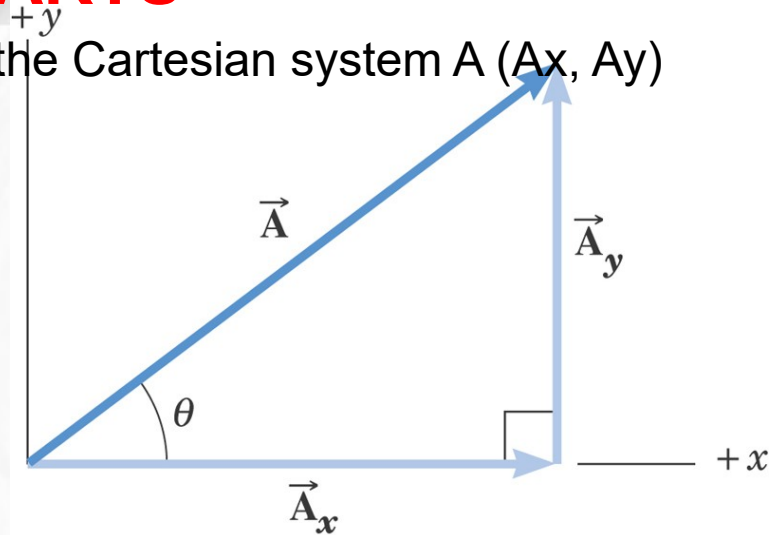
From tail run  
Then rise to find head.



## VECTORS in PARTS



The vector A has 2 components in the Cartesian system A ( $A_x, A_y$ )



If **A is a vector displacement** (walking/moving from start to end)  
Then  $A_x$  is the horizontal displacement or x-component.  
(how far did you move along horizontal or here @ east).  
 $A_y$  is the vertical component or y-component how far did you move  
along vertical or here @ North).

If **A is a velocity**.  $A_x$  is how fast you move along horizontal  
Or how fast you move @ east.  $A_y$  is how fast you move along  
Vertical or @ North.

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If **A is a force**.  $A_x$  is pull/push along the east.  $A_y$  the pull/push along  
west

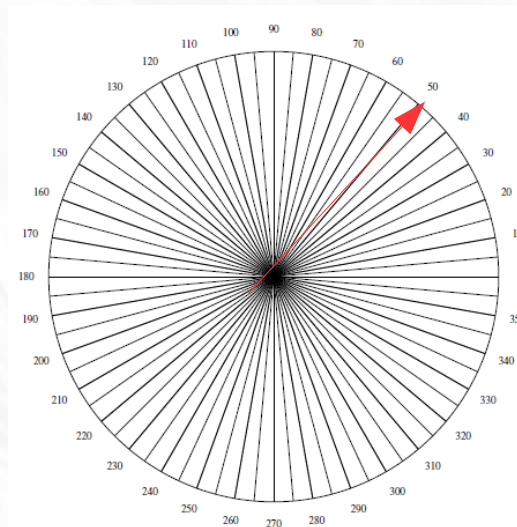
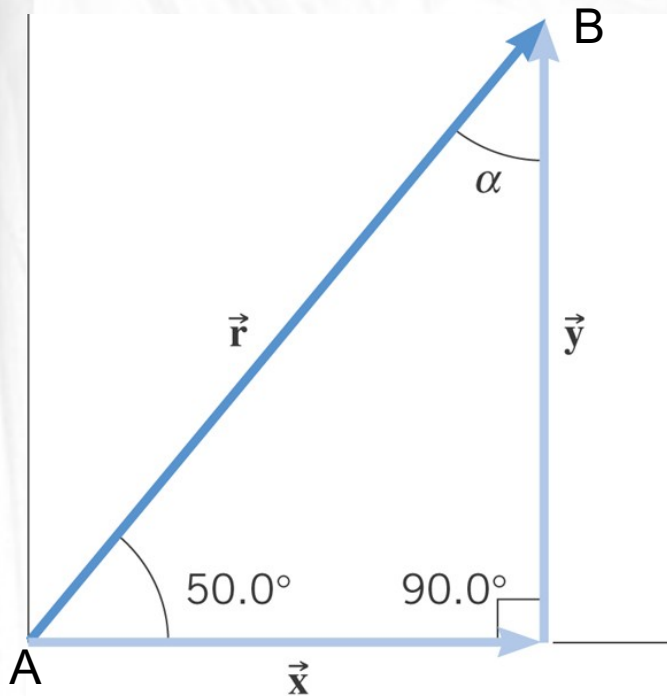
## Example

A displacement vector has a magnitude of 175 m and points at an angle of 50.0 degrees relative to the x axis. Find the x and y components of this vector.

- **R = 175m@50 degrees CCW about x-axis**

**X and Y (round to nearest one) :**

1. 209m m and 134 m
2. 134m and 113m
3. 113m and 134m



# Trace first the vector !!!!

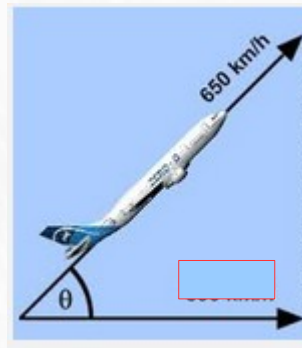
- e) 32 m



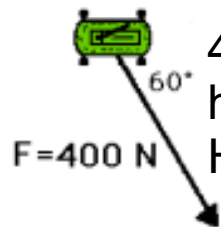




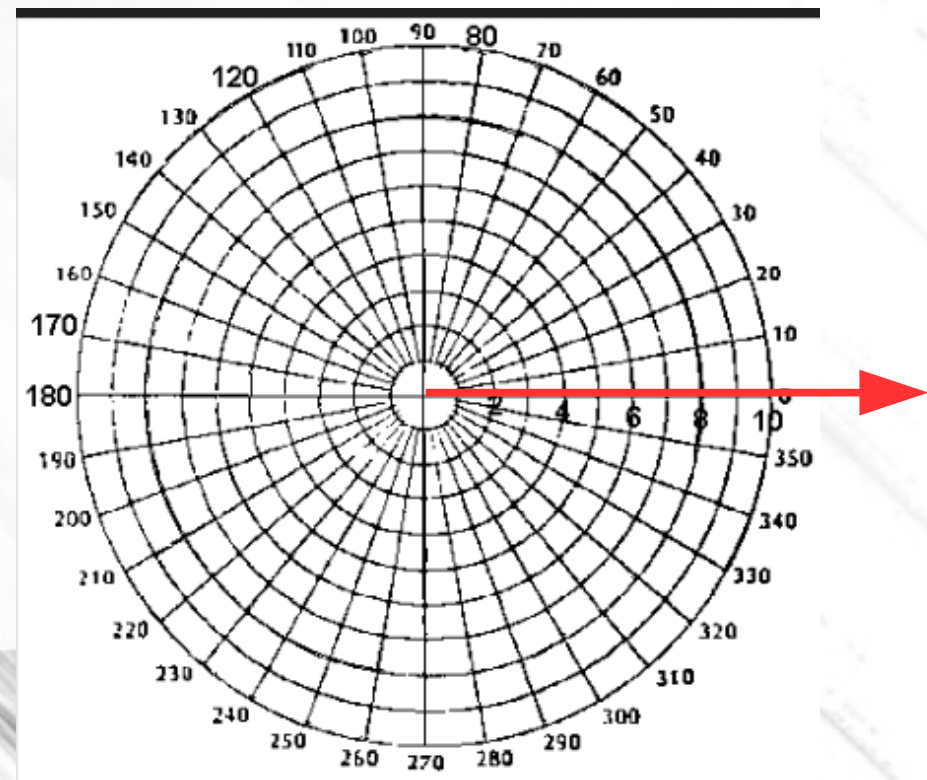
2)  $F = \underline{\hspace{2cm}}$  @  $\underline{\hspace{2cm}}$   
 What is the pull @ east  
 What is the pull @ north

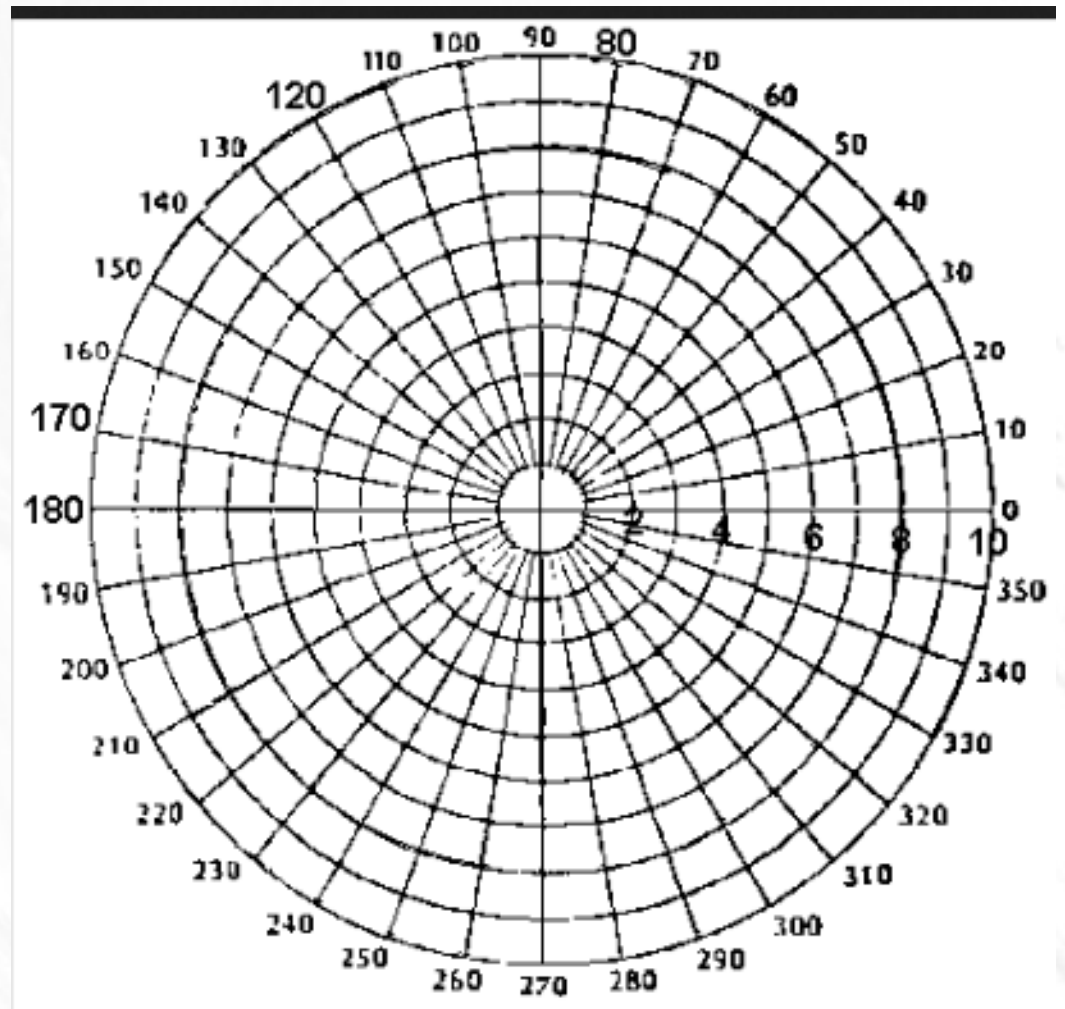
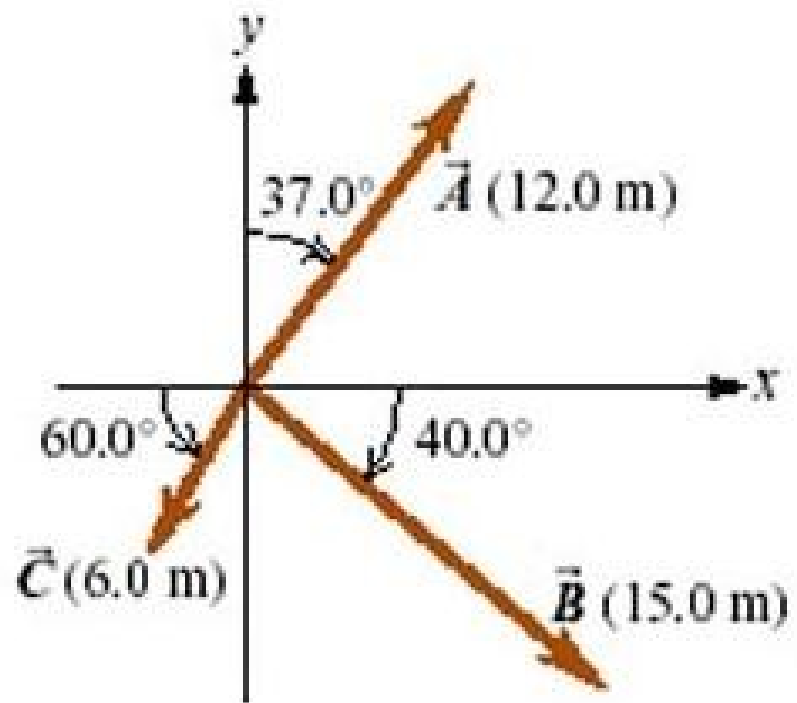


3)  $V = \underline{\hspace{2cm}}$  @  $45^\circ$   
 how fast it is going @ east  
 How fast it is going to North

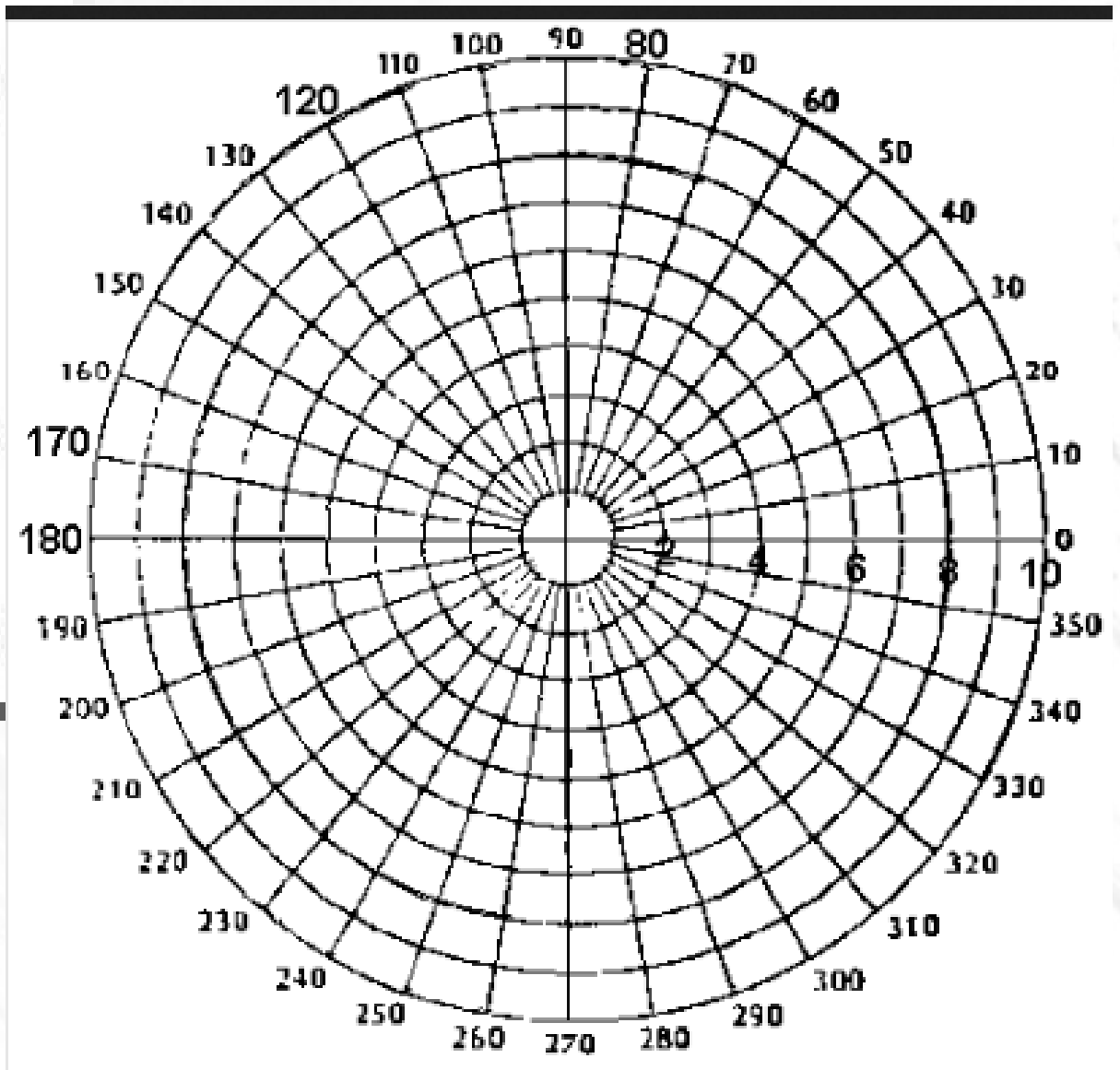
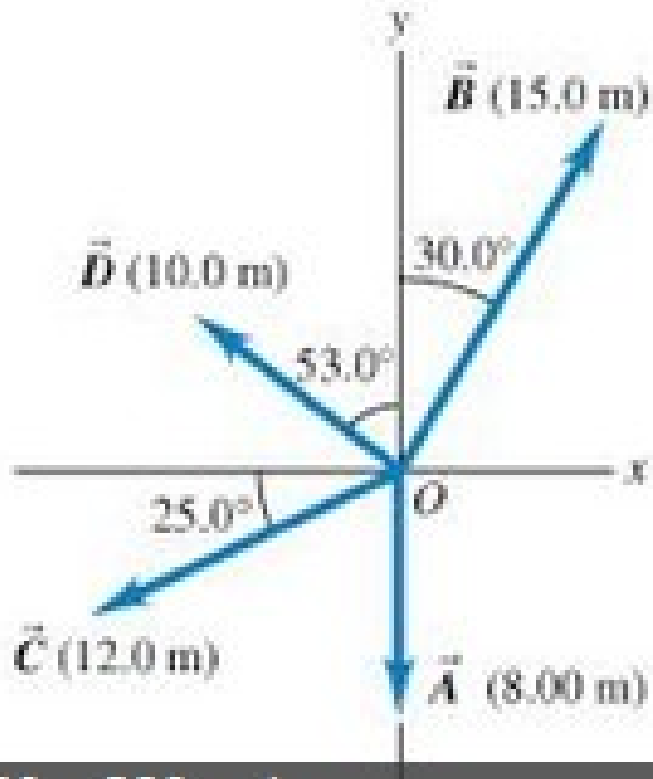


4)  $F = \underline{\hspace{2cm}}$  @  $\underline{\hspace{2cm}}$   
 how much the wind is pushing @ east  
 How much the wind is pushing @ south





Find the components of each vector



- standard notation
- components
- coordinates

For Tuesday

Find the components of each vector



## Assignment:

<https://www.khanacademy.org/math/geometry/hs-geo-trig/hs-geo-trig-ratios-intro/v/basic-trigonometry>

(0) Sum angles =  $180^\circ$

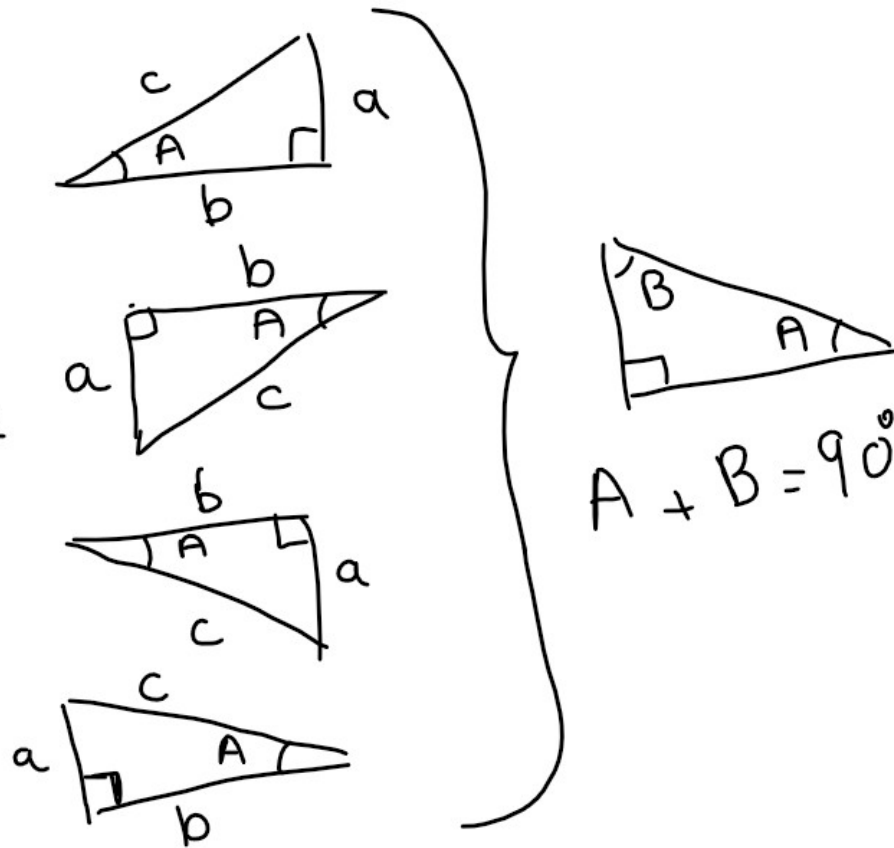
(1)  $a^2 + b^2 = c^2$

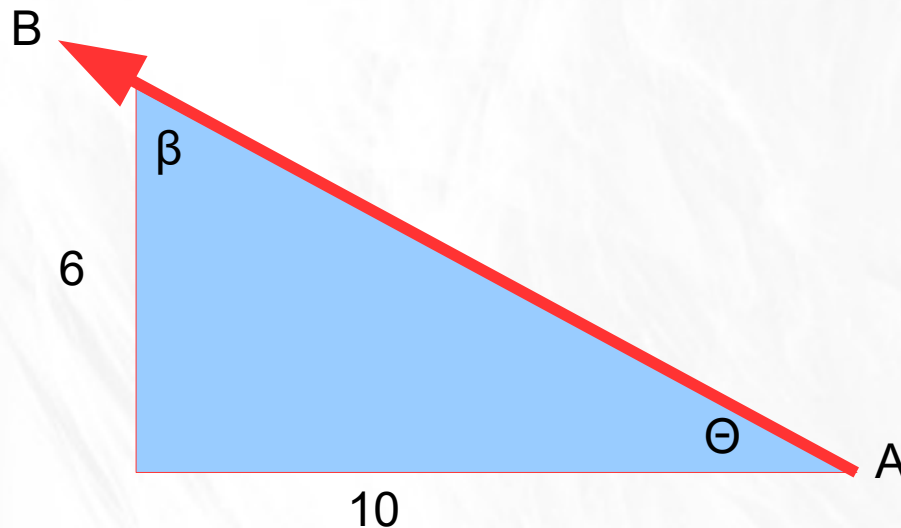
(2)  $A = \tan^{-1}\left(\frac{a}{b}\right)$

(3)  $\frac{a}{b} = \frac{\tan(A)}{1}$  } slope

(4)  $\frac{b}{c} = \frac{\cos(A)}{1}$

(5)  $\frac{a}{c} = \frac{\sin(A)}{1}$





Find the coordinates of AB (cartesian)  
 Find the angle theta  
 Find the standard notation

2) A vector AB has the components ( 100m, -50m) so its coordinates are  $X=100$   $Y = -50$

Draw the vector in a X-Y coordinate system.

Use Pythagorean theorem to find the magnitude of the vector

Use  $\tan^{-1}$  to find one of the angle the vector makes with the horizontal

What is the standard notation notation ?  $AB = \underline{\hspace{1cm}} @ \underline{\hspace{1cm}}$

3) what about a vector velocity  $V_x=115\text{m/s}$  and  $V_y=200\text{m/s}$

Same questions

4) vector V (  $-100\text{m/s}$ ,  $-100\text{m/s}$  ) same questions

Find the components of each vector, the magnitude and the direction

